

# Welcome

## Science Update: Sea Level Rise – What It Is; Why It's Such a Problem; What We Can Do About It

April 7, 2022  
7:00 PM ET

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Transforming science education to benefit all through professional learning, partnerships and advocacy.

# NSTA Virtual Program Norms



The National Science Teaching Association strongly supports diversity, equity and inclusion in the classroom, and in all of our programs. We are committed to providing a welcoming, safe, productive, harassment-free environment for all participants of our events and programs, regardless of their gender, gender identity, sexual orientation, ability, ethnicity, race, color, age, marital status, veteran status, socioeconomic status or religion.

We ask that all attendees be mindful of their surroundings and of their fellow participants. All participants are expected to exercise consideration and respect in their speech and actions, and to refrain from demeaning, discriminatory, or harassing behavior and speech.

NSTA does not allow promotion of other products in our chats during web seminars. We ask that attendees keep the conversation on topic, use positive language and remain courteous of others throughout the event, and allow everyone time to participate in the chat.

# Meet Today's Presenter...



**William Sweet**  
National Oceanic and  
Atmospheric Administration

# Sea Level Rise – What it is; Why it's Such a Problem; What we Can do About it!

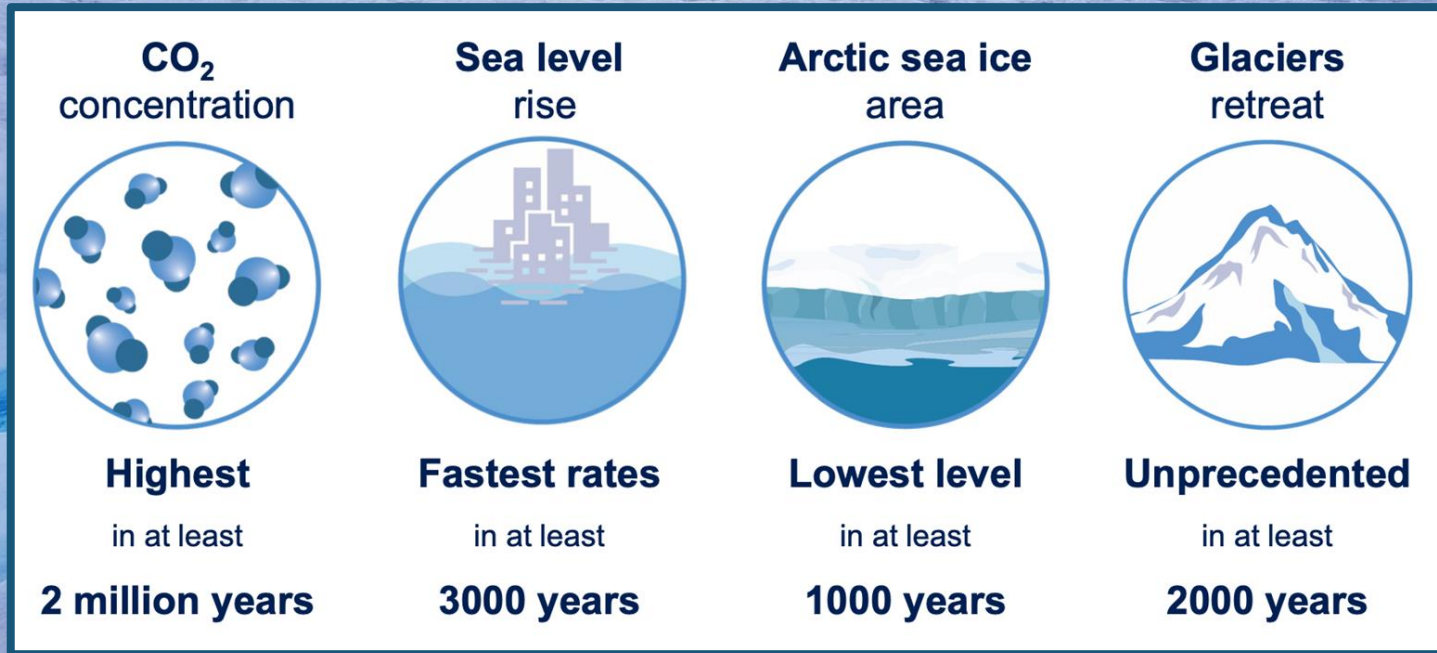
**National Science Teaching Association**  
**Science Update**  
**April 7, 2022**

**William Sweet**  
National Oceanic and Atmospheric Administration



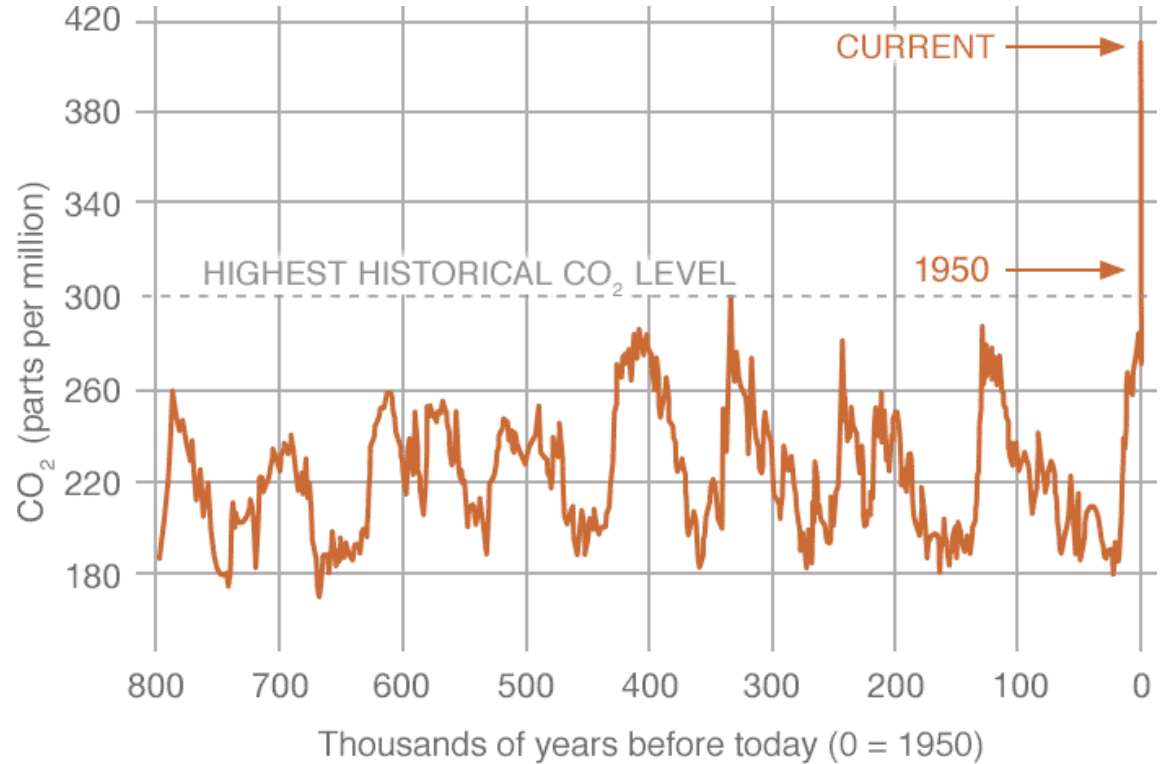
# IPCC Sixth Assessment Report

(Bob Dylan: 'times, they are a changing')



# Increasing Emissions

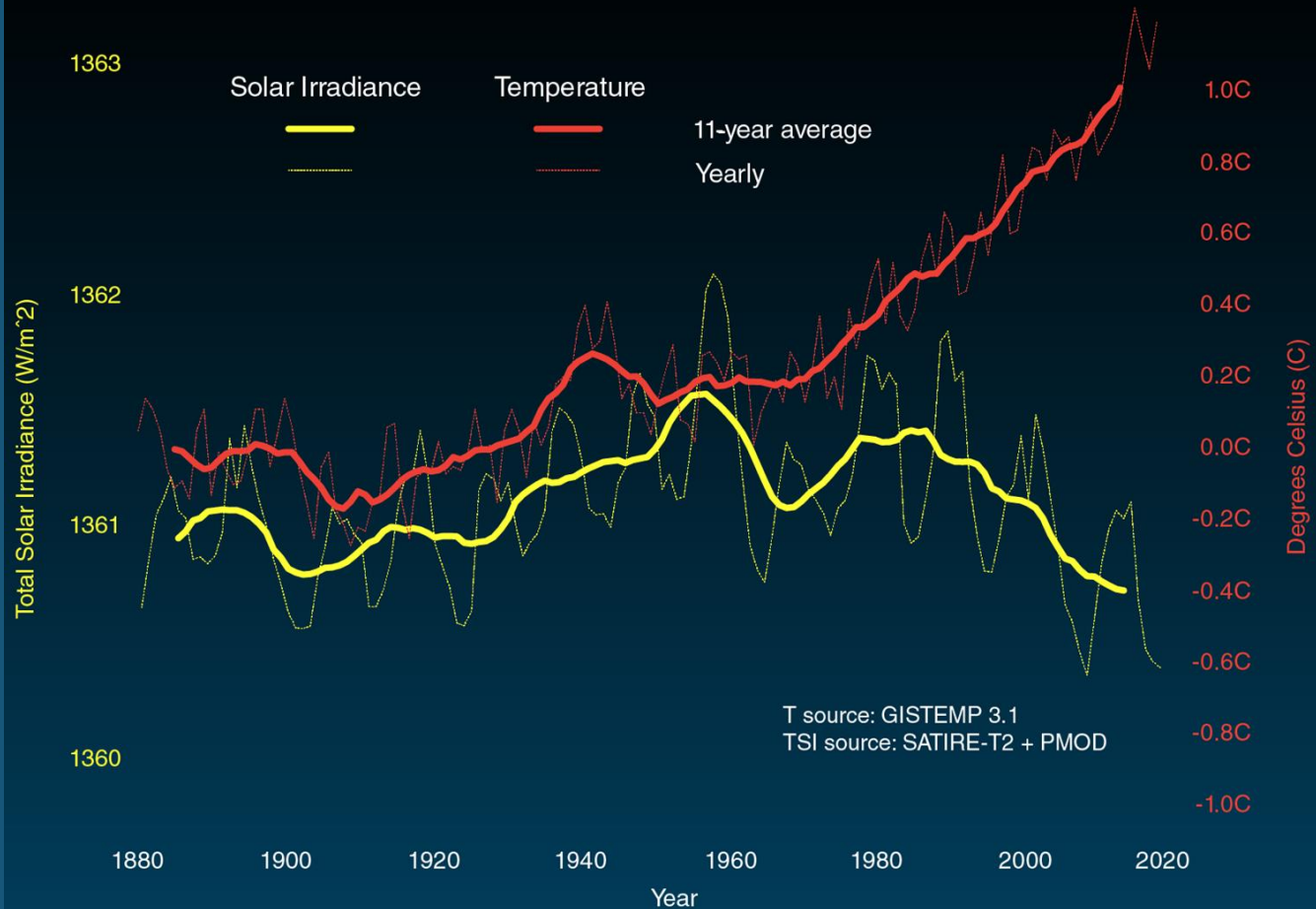
Carbon dioxide emissions are driving an increase in atmospheric and ocean temperatures.



# Rising Temps

Global temperatures are rising, and 90% of excess heat is being absorbed by the ocean.

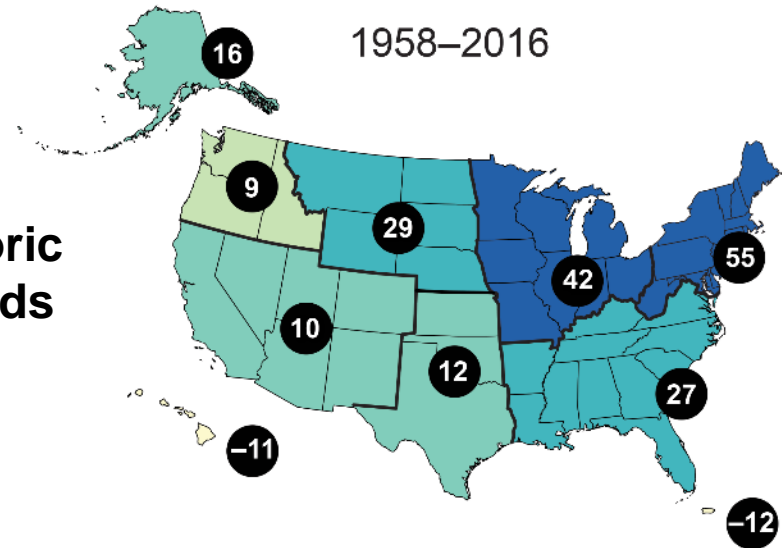
## Temperature vs Solar Activity



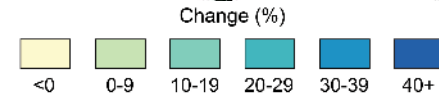
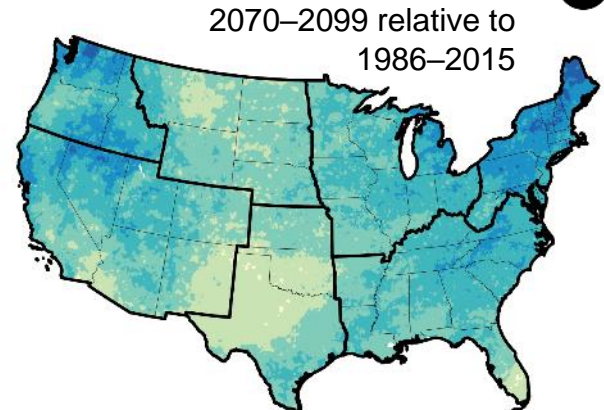
# Precipitation

- Upward trend in precipitation frequency and intensity
- More frequent extreme rainfall events are projected, especially in the northeast.

## Historic Trends



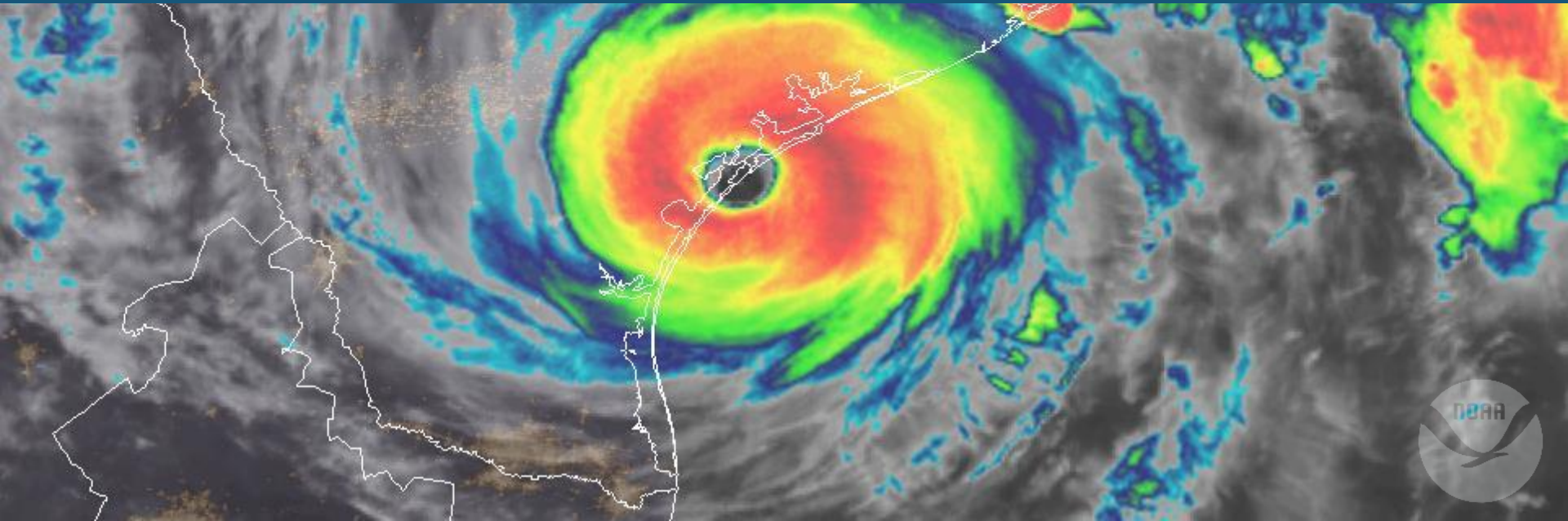
## Future Projections (Lower Emissions: RCP4.5)





# Hurricanes and Storms

- Atlantic and NE Pacific hurricane rainfall and intensity to increase (NCA4)
- Frequency and severity of West Coast landfalling “atmospheric rivers” to increase (NCA4)



# Sea Level Rise

The rate of rise is accelerating and the U.S East and Gulf Coasts are higher than average.

EARTHDATA

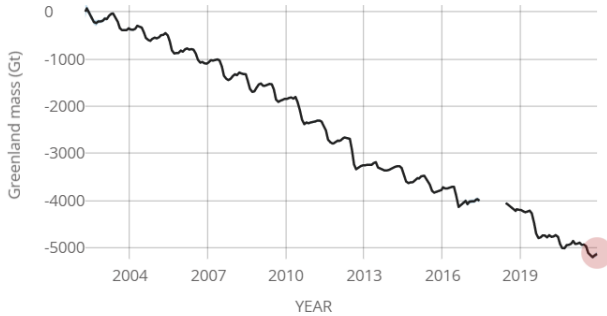
## Greenland

SATELLITE DATA: 2002-PRESENT

Data source: Monthly measurements. Credit: JPL

RATE OF CHANGE

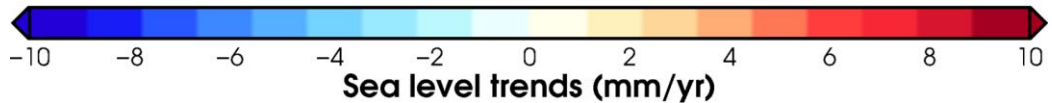
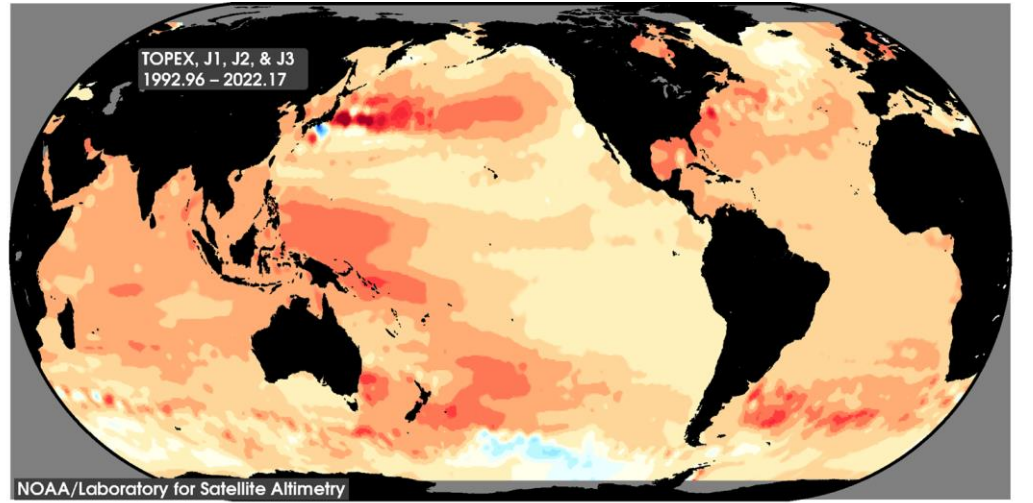
↓ 275  
(± 21) Gt/yr



Click+drag to zoom

RESET

Get Data: [HTTP](#) | Snapshot: [PNG](#)



GLOBAL MEAN SEA LEVEL

↑ 3.4 ± 0.4 mm/yr

OCEAN MASS

↑ 2.1 ± 0.3 mm/yr

STERIC HEIGHT

↑ 1.2 ± 0.2 mm/yr

GREENLAND ICE MASS CHANGE

↓ 275 ± 21 Gt/yr

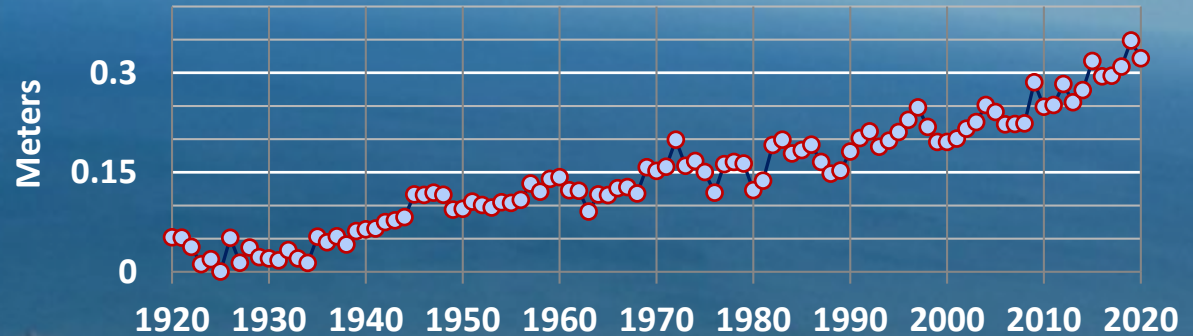
ANTARCTICA ICE MASS CHANGE

↓ 152 ± 39 Gt/yr

# Sea Level Rise

- About 1 foot (0.3 m) of rise over the last 100 years along the US coastline
- The rate of rise has been accelerating over the last 50 years...where is it going?

US Relative Sea Level Rise  
(average since 1920s)



# 2022 Interagency Sea Level Rise Report

- How much sea level rise should the U.S. expect by 2050?
- How much could sea levels rise by 2100 or 2150?
- What is the risk of a:
  - 2-foot (disruptive) flood
  - 3-foot (typically damaging) flood
  - 4-foot (often-destructive) flood
  - now and by 2050?












## Global and Regional Sea Level Rise Scenarios for the United States




William V. Sweet/NOAA, Benjamin D. Hamlington/NASA JPL, Robert E. Kopp/Rutgers, Christopher P. Weaver/EPA, Patrick L. Barnard/USGS David Bekaert/NASA JPL, William Brooks/NOAA, Michael Craghan/EPA, Gregory Dusek/NOAA, Thomas Frederikse/NASA JPL, Gregory Garner/Rutgers, Ayesha S. Genz/Uni of Hawaii, John P. Krasting/NOAA, Eric Larour/NASA JPL, Doug Marcy/NOAA, John J. Marra/NOAA, Jayantha Obeysekera/Florida International, Mark Osler/NOAA, Matthew Pendleton/NOAA, Daniel Roman/NOAA, Lauren Schmied/FEMA, Will Veatch/U.S. Army Corps of Engineers, Kathleen D. White/U.S. Department of Defense, Casey Zuzak/FEMA



# What are Sea Level Rise Scenarios?

- Assess the plausible future range
- Incorporate future emissions, warming and our current scientific understanding
- 5 possibilities from Low to High (1 to 6.5 ft by 2100)

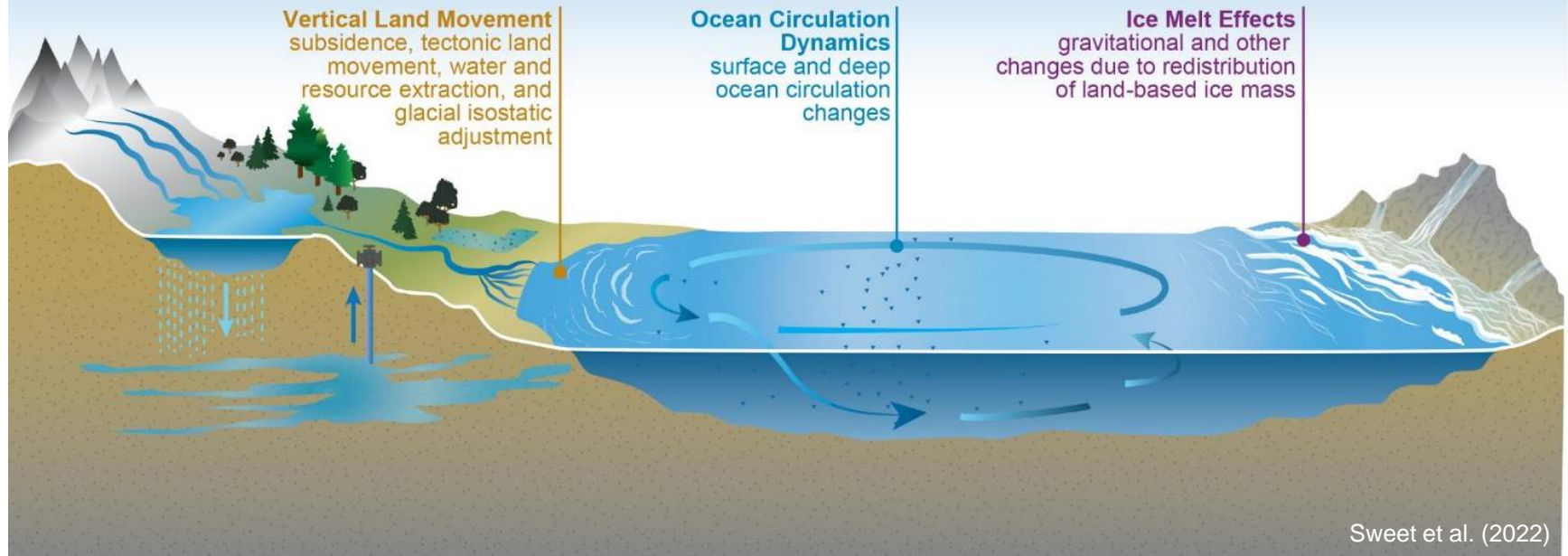
Sea Level Scenario in this Report (2100 Value)	Low Emissions Low Warming	High Emissions High Warming	Considers Possible Rapid Ice Sheet Loss
Low (0.3 m)			
Intermediate-Low (0.5 m)			
Intermediate (1 m)			
Intermediate-High (1.5 m)			
High (2m)			

 Small Contribution       Medium Contribution       Large Contribution

# Global Sea Level Rise and Regional Differences

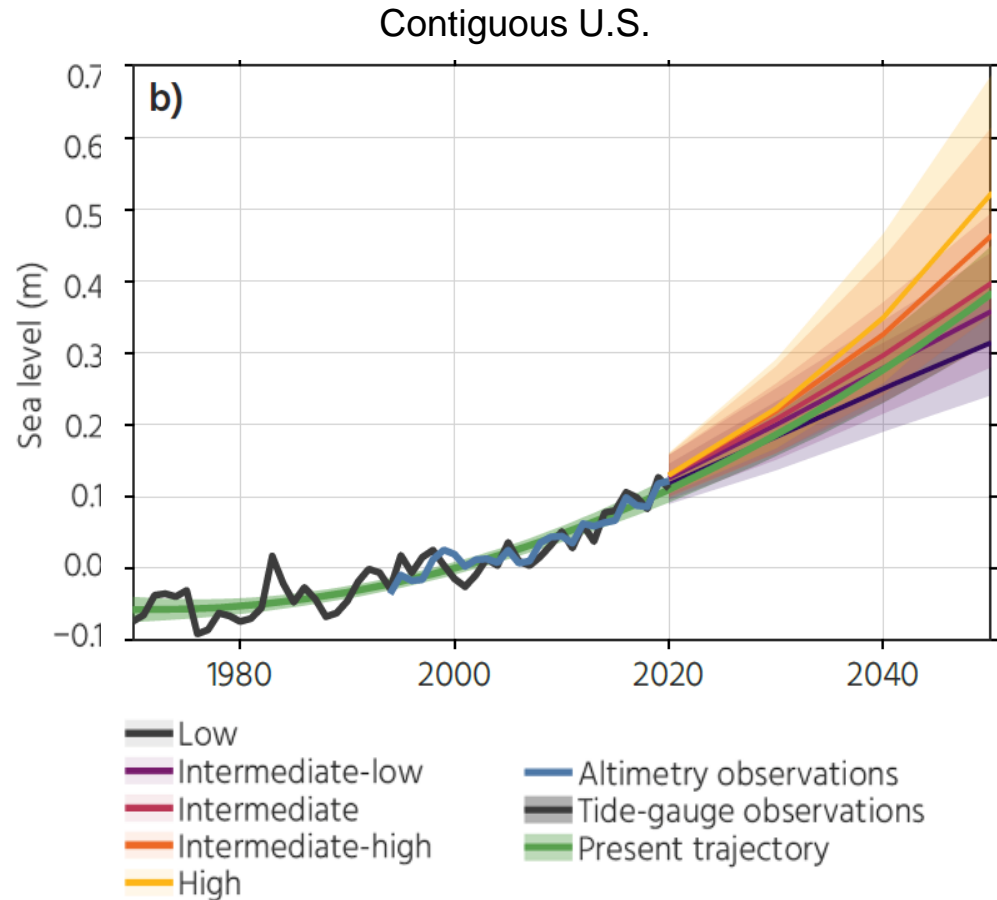
## Regional Sea-Level Rise

Factors that Affect Regional and Local Sea Level



# U.S. sea level rise will be, on average, 10-12 in. higher in the next 30 years (2020-2050)

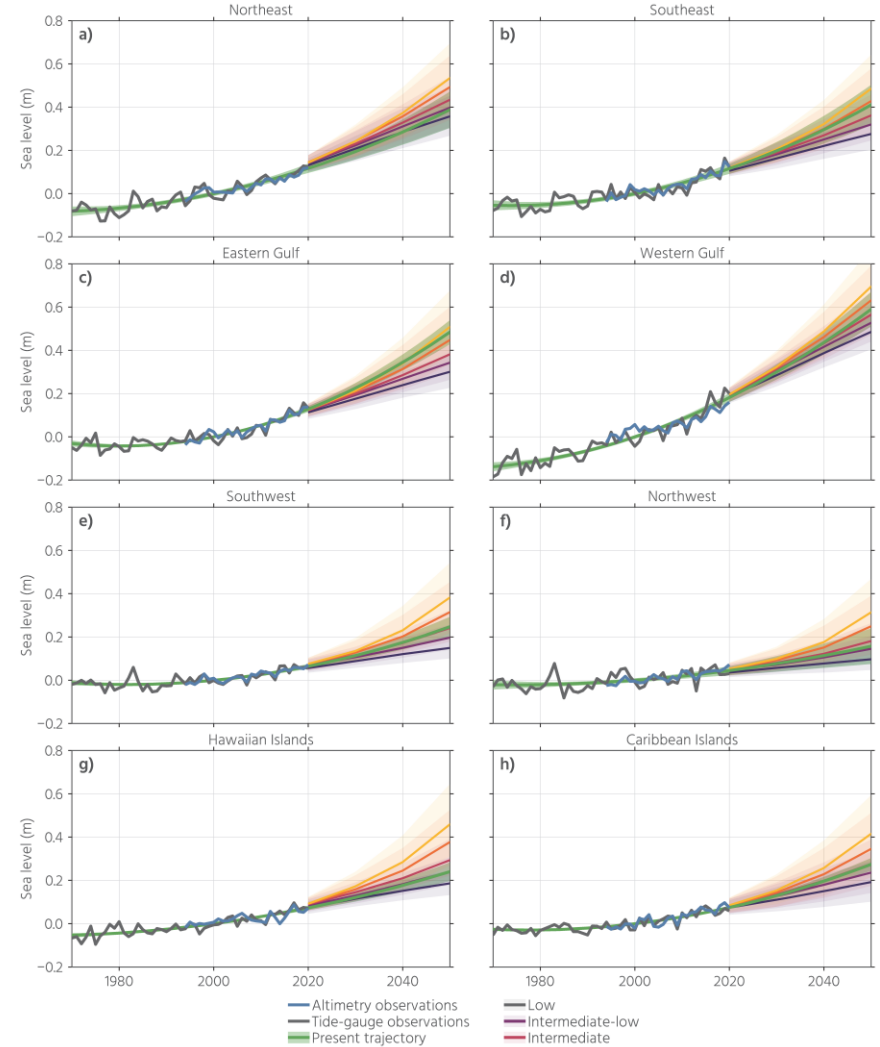
- Equals rise from the past 100 years
- Observations agree with models
- Smaller range across scenarios and greater confidence in the potential SLR in next 30 years



# Regionally, U.S. sea level rise will be different.

By 2050, sea levels are expected to be higher (2020-2050):

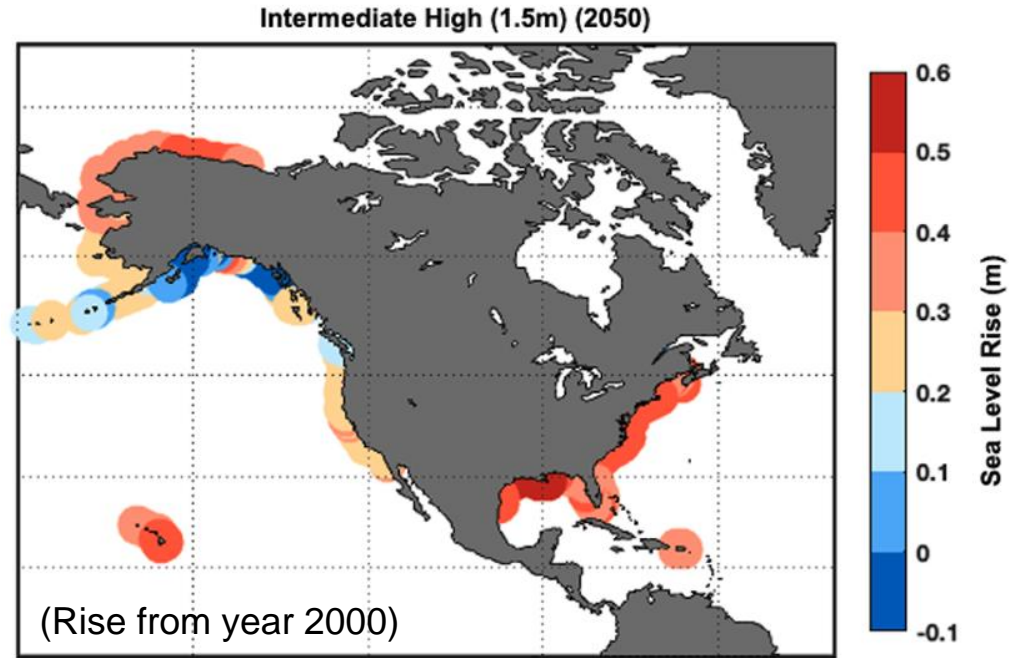
- 0.25 - 0.35 m for the East coast
- 0.35 - 0.45 m for the Gulf coast
- 0.1 - 0.2 m for the West coast
- 0.2 - 0.25 m for the Caribbean
- 0.15 - 0.2 m for the Hawaiian Islands
- 0.2 - 0.25 m for northern Alaska





# Sea Level Rise Scenarios Differ Geographically

- Physical processes affect U.S. coastlines differently
- Higher sea levels projected along East and Gulf vs. West Coasts
- Greenland vs. Antarctica ice melt matters for East/Gulf Coasts.
- Observations and models agree

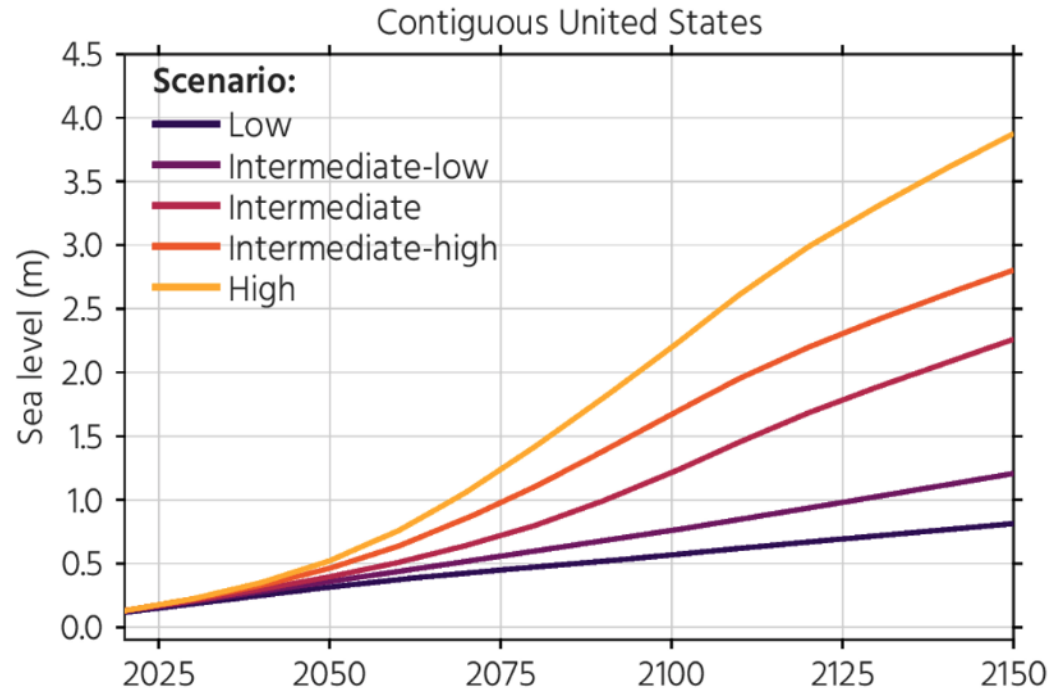


# Higher global temperatures increase the risk of higher sea level rise in 2100 and beyond

## Key Takeaways

Scenario Ranges Relative to 2000:

- 2100: 2 - 7 ft (0.6 - 2.2m)
- 2150: 3 - 13 ft (0.8 - 3.9m)
- Ranges are driven by future emissions and known-unknown ice sheet dynamics



# Coastal County Snapshots – Sea Level Rise

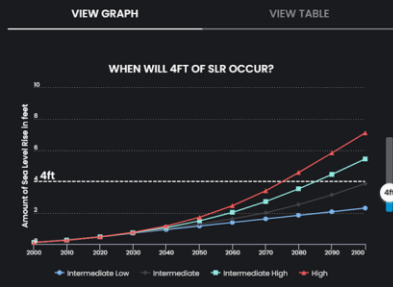
- New interactive interface contains maps, charts and graphs
- Ability to produce printed report to distribute to others
- Examines exposure at different inundation levels (2,4,6,8,10 ft MHHW)

## When Is the Time to Act? Now!

Because a number of factors are involved, sea level rise projections are often expressed as scenarios. For projects involving structures with a long lifespan or where a loss would be catastrophic (power plants, ports, hospitals), the higher sea level rise scenarios should be considered. For projects with a shorter lifespan (bike paths, golf courses, parks), lower sea level rise scenarios may be appropriate.

Choose a set of sea level rise projections. Click [here](#) to learn about sea level rise projections.

2022 Projections



Based on projections for the St. Petersburg, FL tide gauge (the closest gauge to your county).

Data Sources

NOAA (SLR Inundation) various dates  
NOAA et al. (SLR Projections Update) 2022

Coastal County Snapshots

Sea Level Rise  
Hillsborough County, FL

### Sea Level Rise

Visualize sea level rise exposure with this snapshot. Consider incorporating this data into all community planning strategies. In many communities, rising sea levels are already increasing the impacts of high tide flooding and storm surge events.

#### People at Risk

Rising population numbers exacerbate potential flooding risk. Impacts can be even greater when social vulnerability factors (age, income, capabilities) are involved, as these citizens may not be able to adequately prepare and respond.

**1%**  
of Hillsborough County's total population (4,033 people) resides in low-lying areas (less than 2 feet of sea level rise). As is already the case in many parts of the country, these areas are the first to experience impacts.



#### Flooded Facilities Can't Provide Critical Services

Fire and police stations, hospitals, shelters, these facilities play a central role in response and recovery. Understanding future exposure can help reduce damages and the conditions that make these services unavailable.

**0%**

of Hillsborough County's critical facilities reside in low-lying areas (less than 2 feet of sea level rise). As is already the case in many parts of the country, these areas are the first to experience impacts.



Data Sources: 1. NOAA (SLR Inundation) various dates; 2. USFWS (2020)

Coastal County Snapshots

Date Printed: 3/23/2022

Sea Level Rise  
Hillsborough County, FL

### Being Underwater Is Not a Good Business Plan

Flood-related losses of services, revenues, and salaries can hit a community hard.

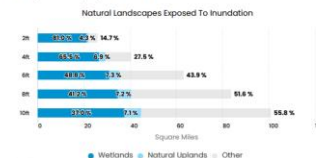
**0%**

of Hillsborough County's businesses are within low-lying areas (less than 2 feet of sea level rise). As is already the case in many parts of the country, these areas are the first to experience impacts.

Data Sources: 1. ESR (2018); 2. NOAA (SLR Inundation) various dates

#### Creating a Better Future: Yes, It Can Be Done

Make it a goal: more natural areas (wetlands, forests, parks, dunes, etc.) to absorb floodwaters and protect the community, and less development in flood-prone areas. Consider not only today's floodplain, but also the floodplain extent projected for the future.



Data Sources: 1. NOAA (High Resolution Land Cover) various dates; 2. NOAA (Regional Land Cover) (MHI, 2018); 3. NOAA (SLR Inundation) various dates

#### When Is the Time to Act? Now!

Because a number of factors are involved, sea level rise projections are often expressed as scenarios. For projects involving structures with a long lifespan or where a loss would be catastrophic (power plants, ports, hospitals), the higher sea level rise scenarios should be considered. For projects with a shorter lifespan (bike paths, golf courses, parks), lower sea level rise scenarios may be appropriate.

Inundation (feet)	Intermediate Low	Intermediate	Intermediate High	High
2ft	<2000	<2000	<2000	<2000
4ft	<2000	<2000	<2000	<2000
6ft	<2000	<2000	<2000	<2000
8ft	<2000	<2000	<2000	<2000
10ft	<2000	<2000	<2000	<2000

Based on projections from the 2022 Sea Level Rise Technical Report for the St. Petersburg, FL tide gauge (the closest gauge to your county).

Data Sources: 1. NOAA (SLR Inundation) various dates; 2. NOAA et al. (SLR Projections Update) 2022

Coastal County Snapshots

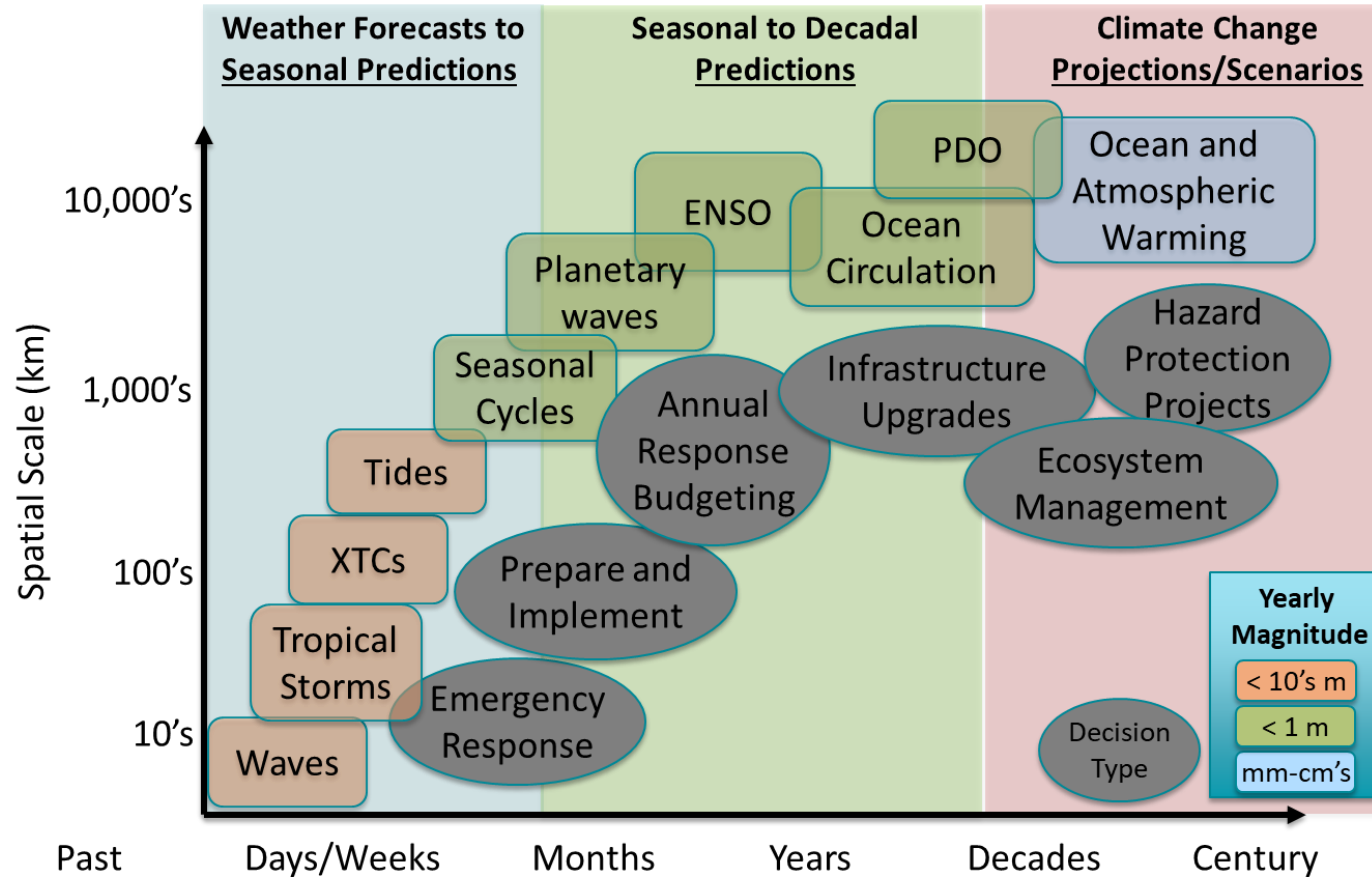
Date Printed: 3/23/2022

# Sea Level Rise Flooding

- (Minor) high tide flooding is twice as likely than 20 years ago along U.S. coastlines.
- The rate of flooding is accelerating along most East and Gulf coastlines.

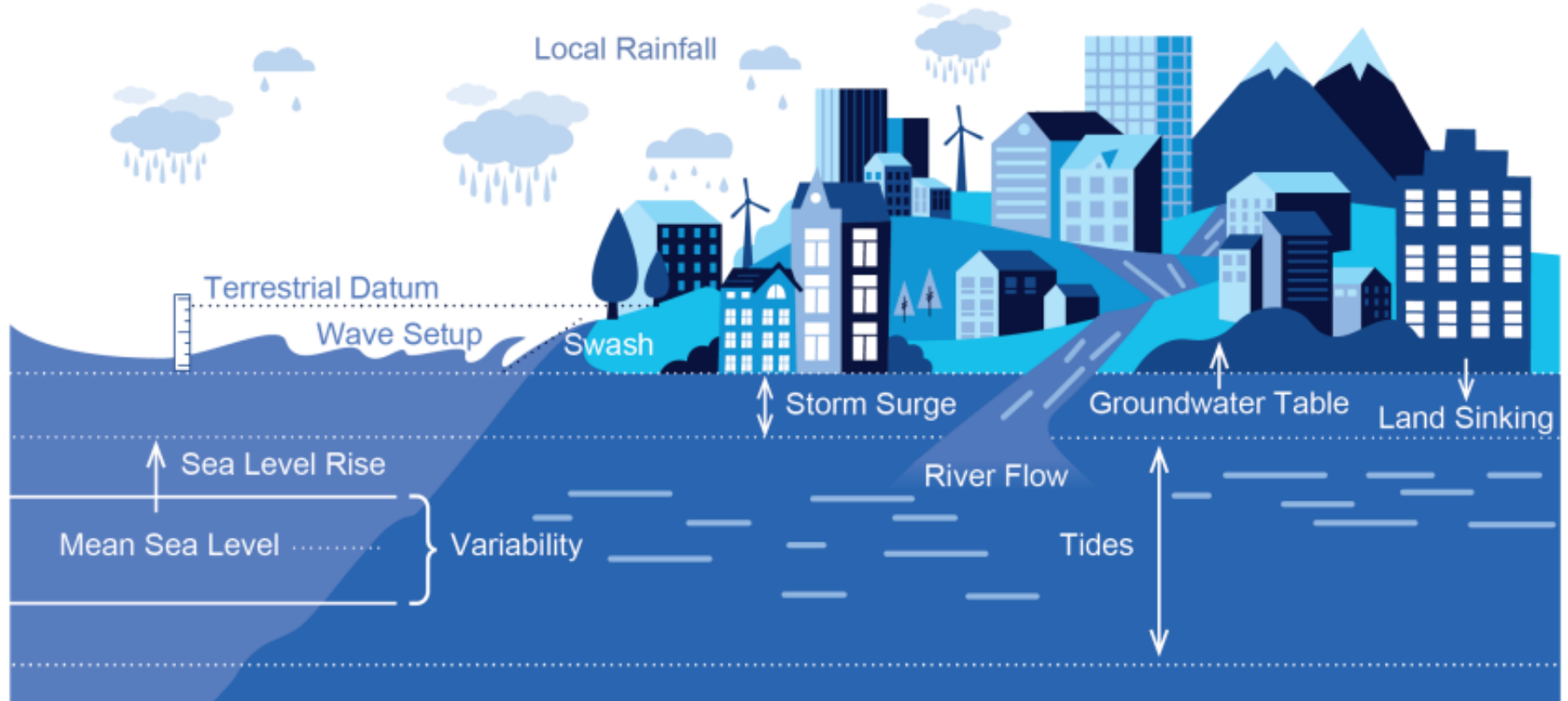


# Physical Process and Time Horizons for Decision Making



# Current and Future Flooding from Many Sources

Higher seas, heavier rains, rising groundwater table



# What are the effects of Sea Level Rise?

POSTCARD  
FROM THE FIELD

## Tune in Tomorrow



Tune into NBC-TV's *Today* show early tomorrow and hear NOAA oceanographer Dr. William Sweet explain why it no longer takes just a local storm to flood coastal areas.

NBC's Al Roker conducts the interview, which spotlights high-tide flooding, often called nuisance flooding because streets can flood and storm drains clog even on sunny days.

For public safety and sound maritime commerce, NOAA's National Water Level Monitoring Network tracks and predicts low tides that lead to ship groundings and high tides that top flood heights, pointing to infrastructure vulnerabilities along our coasts.

Such flooding is often more disruptive than destructive. But with sea-level rise, frequency is increasing, and impacts are mounting.

# Sea Level Rise Flooding...

Is now a  
problem in  
Norfolk, VA





# Sea Level Rise Flooding...



# Is now a problem in Charleston, SC



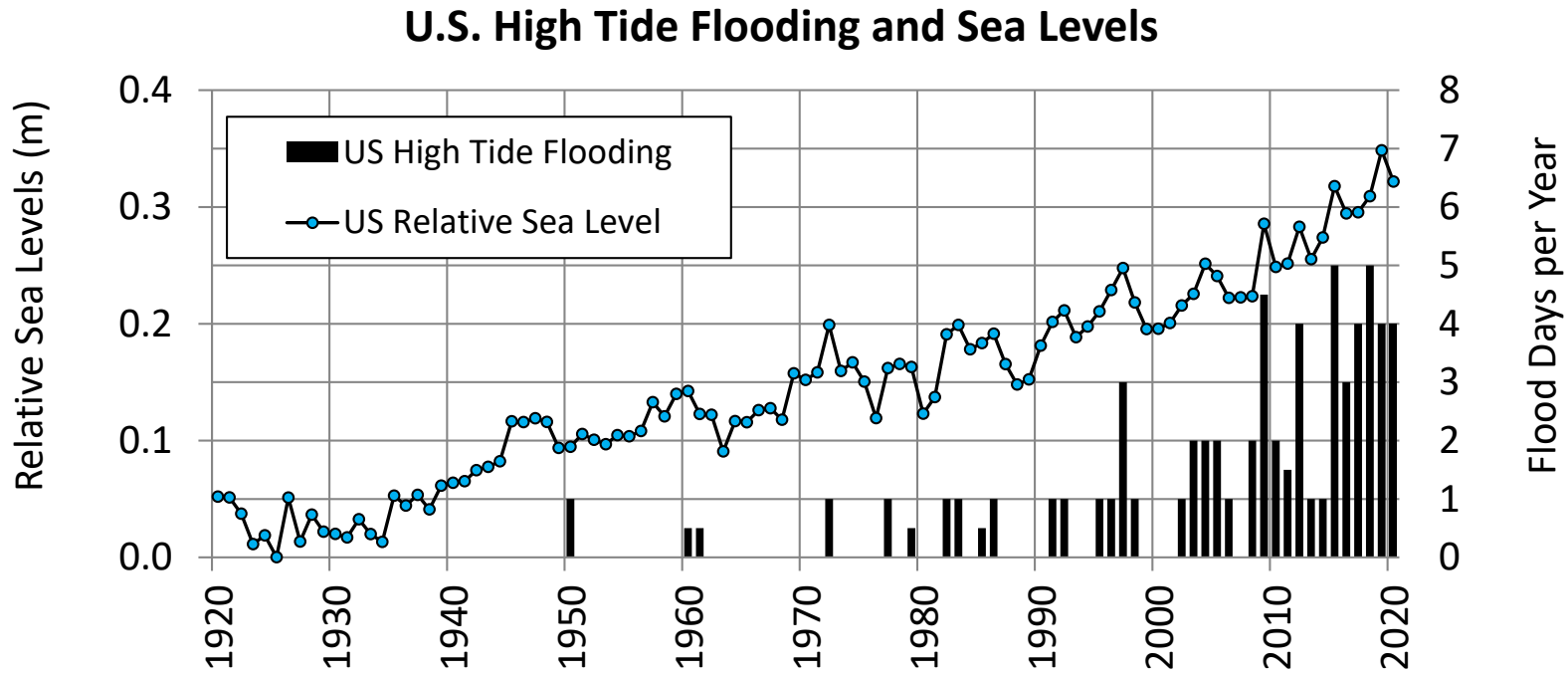
# Sea Level Rise Flooding...



Is now a  
problem in  
Miami, FL



# Effects of Sea Level Rise: Doubling of (Minor) High Tide Flood Risk



# High tide flood risk communication

Minor flooding is about 1.75', moderate is 2.75' and major is 4' above high tide in the St. Petersburg/Tampa Bay region

Minor is usually only disruptive



- **Shallow flooding** in the most vulnerable locations near the waterfront and shoreline resulting in a **low threat of property damage**.
- **Up to 1 foot of inundation** in shoreline and vulnerable areas.

Moderate is typically damaging



- **Widespread flooding** of vulnerable areas will result in an **elevated threat of property damage**.
- **1 to 2 feet of inundation** primarily in shoreline and vulnerable areas.

Major is often destructive



- **Severe flooding** will cause extensive inundation and flooding of numerous roads and buildings resulting in a **significant threat to property and life**.
- **2 to 3 feet or more of inundation**.

# High tide flood risk Alerts

## NOAA Coastal Inundation Dashboard



Coastal Inundation Dashboard

About

Station List

Share Map

Legend

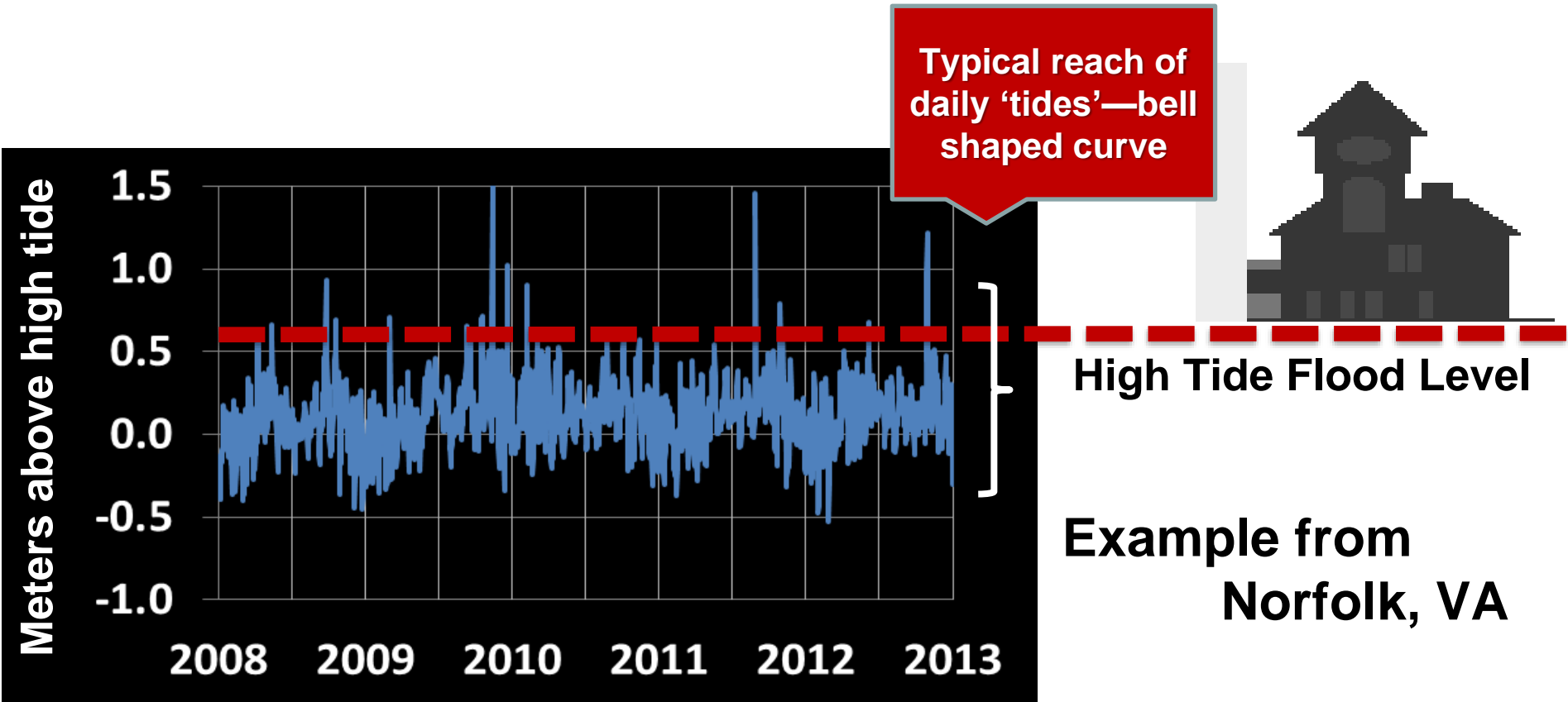
Latest Data

Multi-Station View

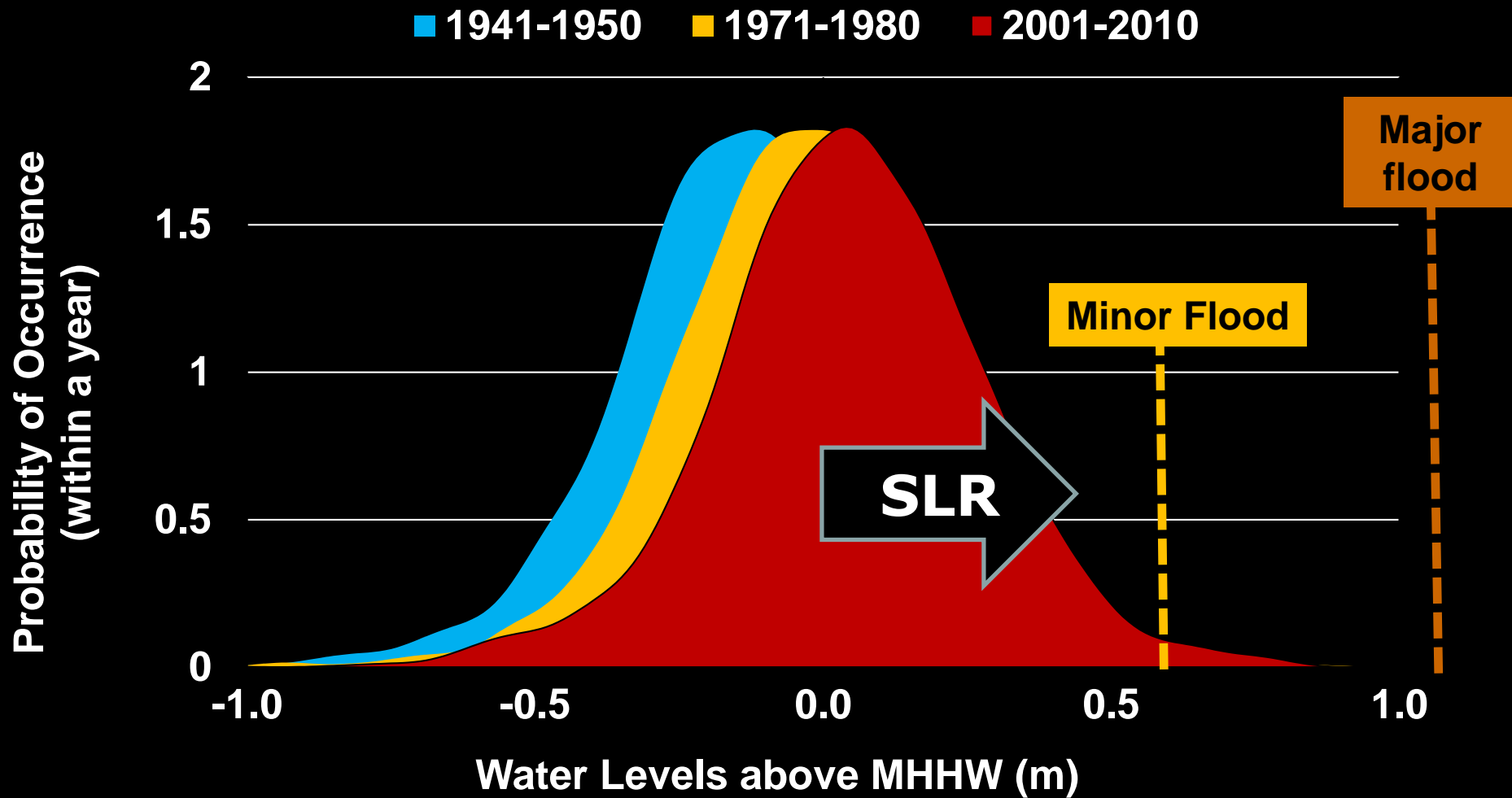


Display Time: Wed, Apr 6, 2022 9:12 am (EDT)

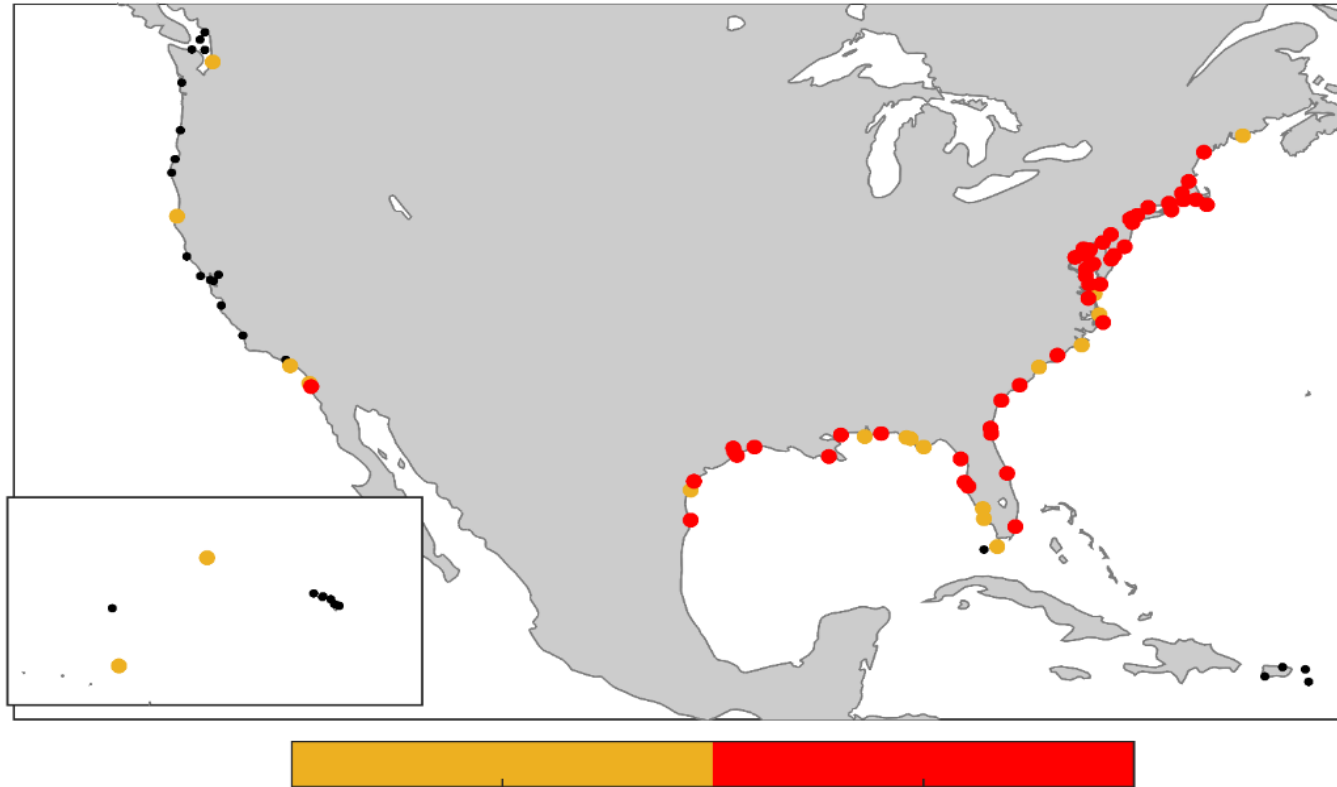
# Sea Level Rise and the Loss of Freeboard



# Daily Highest Water Levels at NOAA Tide Gauge NYC



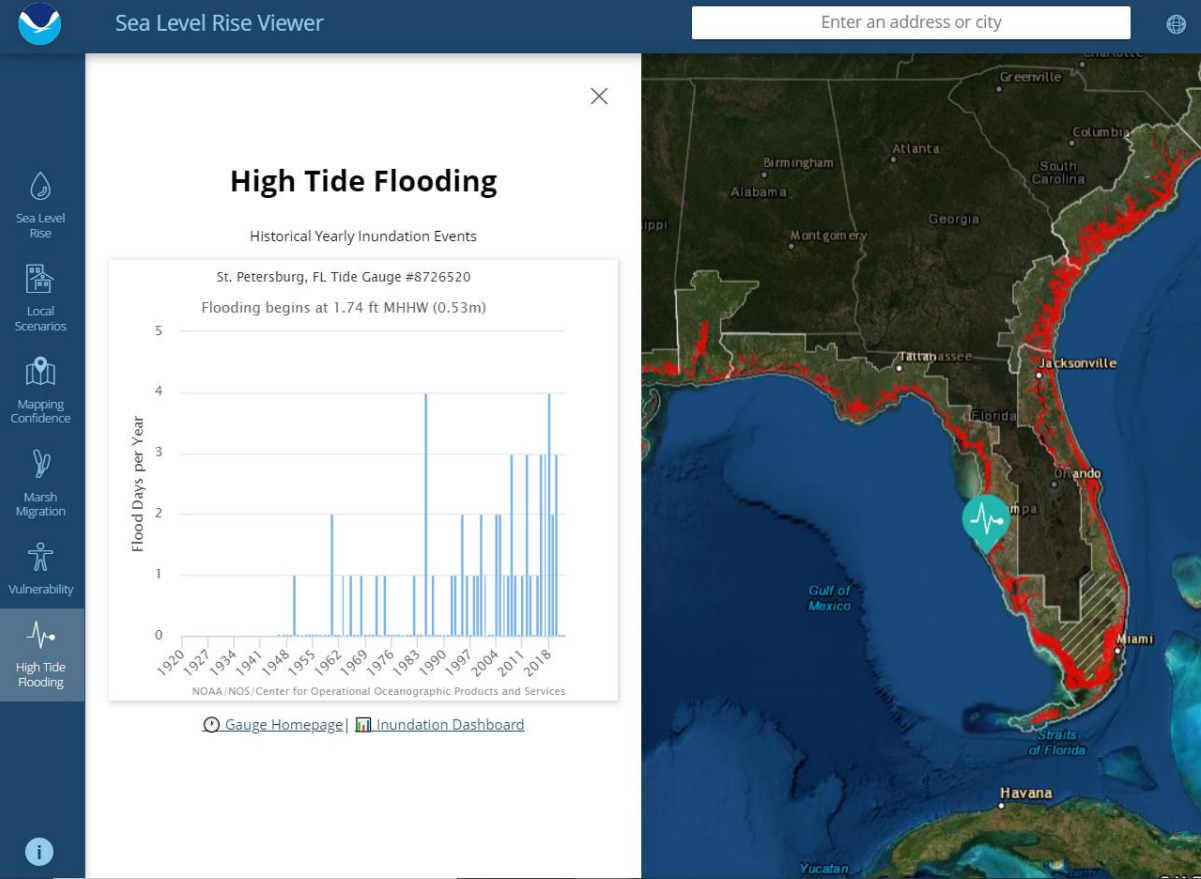
# Sea Level Rise and Acceleration in Flood Frequencies and the Transition from Storm Surge-to-Tidal Flooding





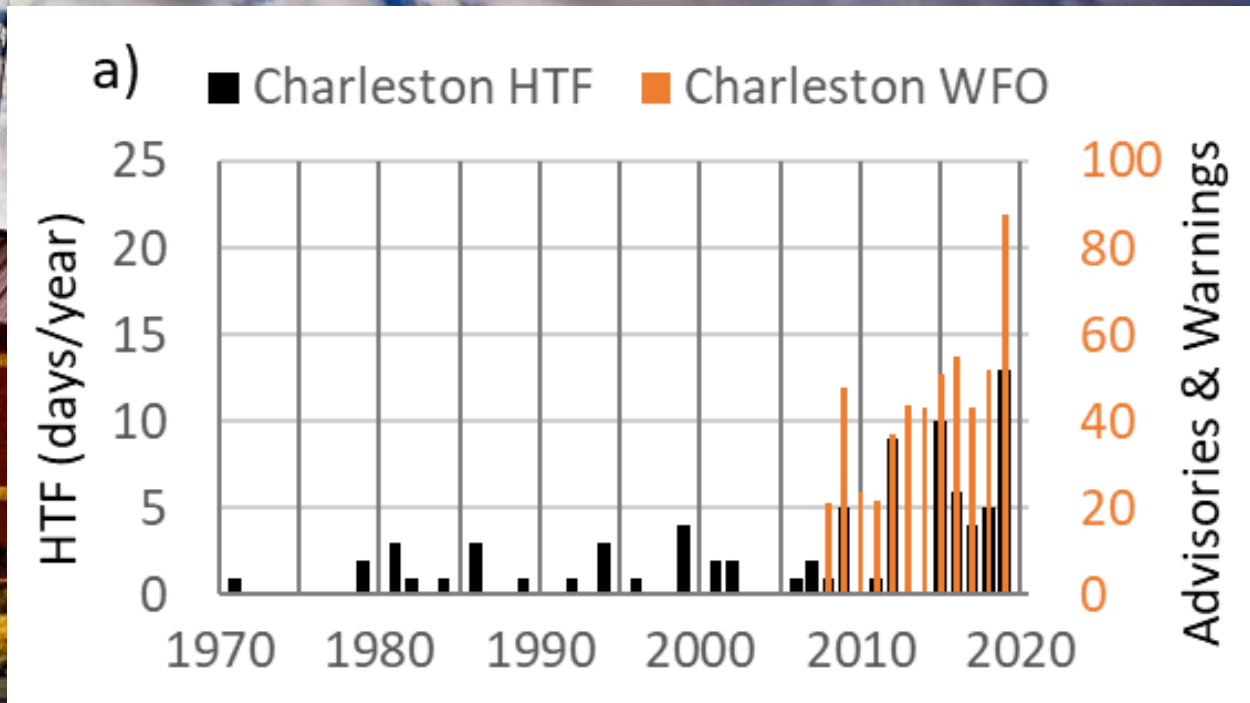
# Sea Level Rise and Acceleration in Flood Frequencies and the Transition from Storm Surge-to-Tidal Flooding

- The annual frequency of minor High Tide Flooding is now accelerating in Tampa Bay region.
- This trend is expected to pick up pace with sea level rise and the 'moon wobble' next decade...



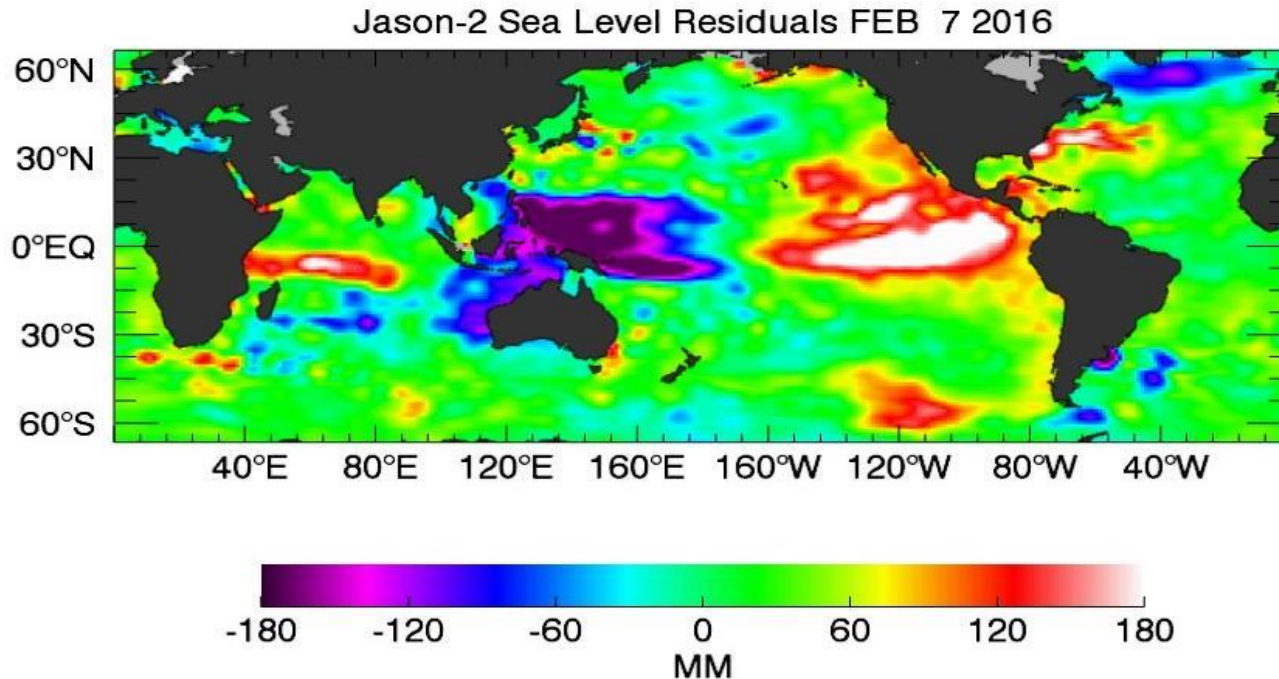
# The Increase in Coastal Flooding is Affecting Daily Activities

## NWS Charleston Weather Forecasting Office (WFO)



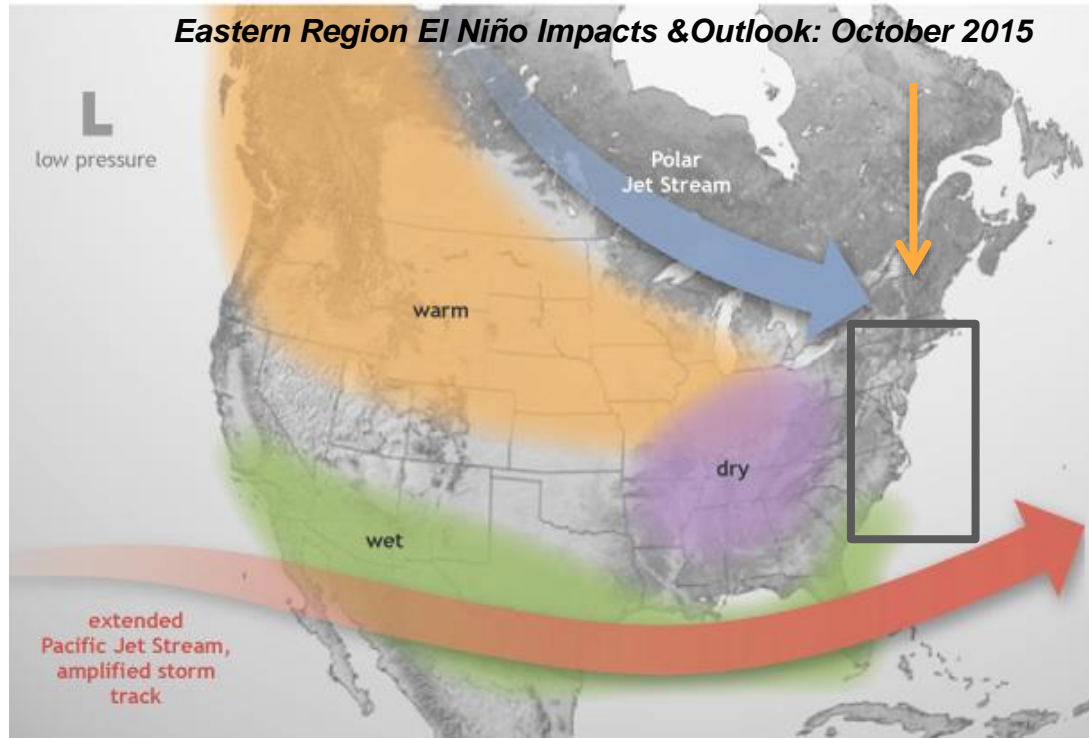
# Year to Year Variability in High Tide Flooding

West Coast: High ocean temperatures, sea levels for months increase the reach of (sometimes more) storms and tides



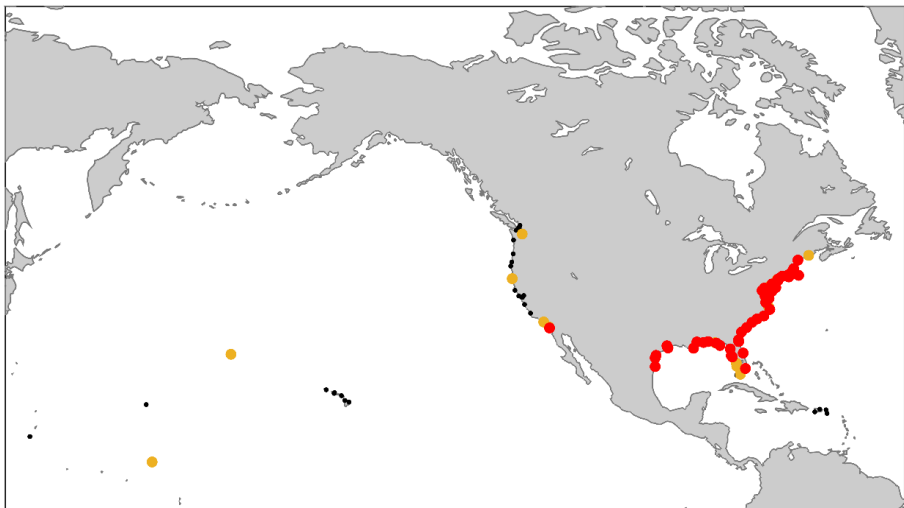
# Year to Year Variability in High Tide Flooding

East Coast: More northerly wind forcing with more frequent storm surges and/or (quiet) anomalies



# Coastal Flooding, El Nino Southern Oscillation and Annual Outlooks

a. Trends in Annual Flood Frequencies



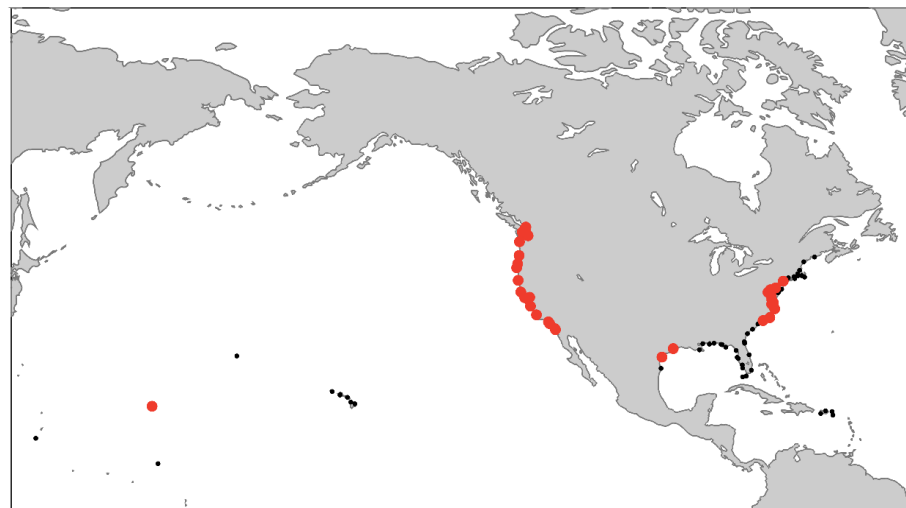
Trend Characterization



Increasing

Accelerating

b. ENSO Effects on Flood Frequency Trends

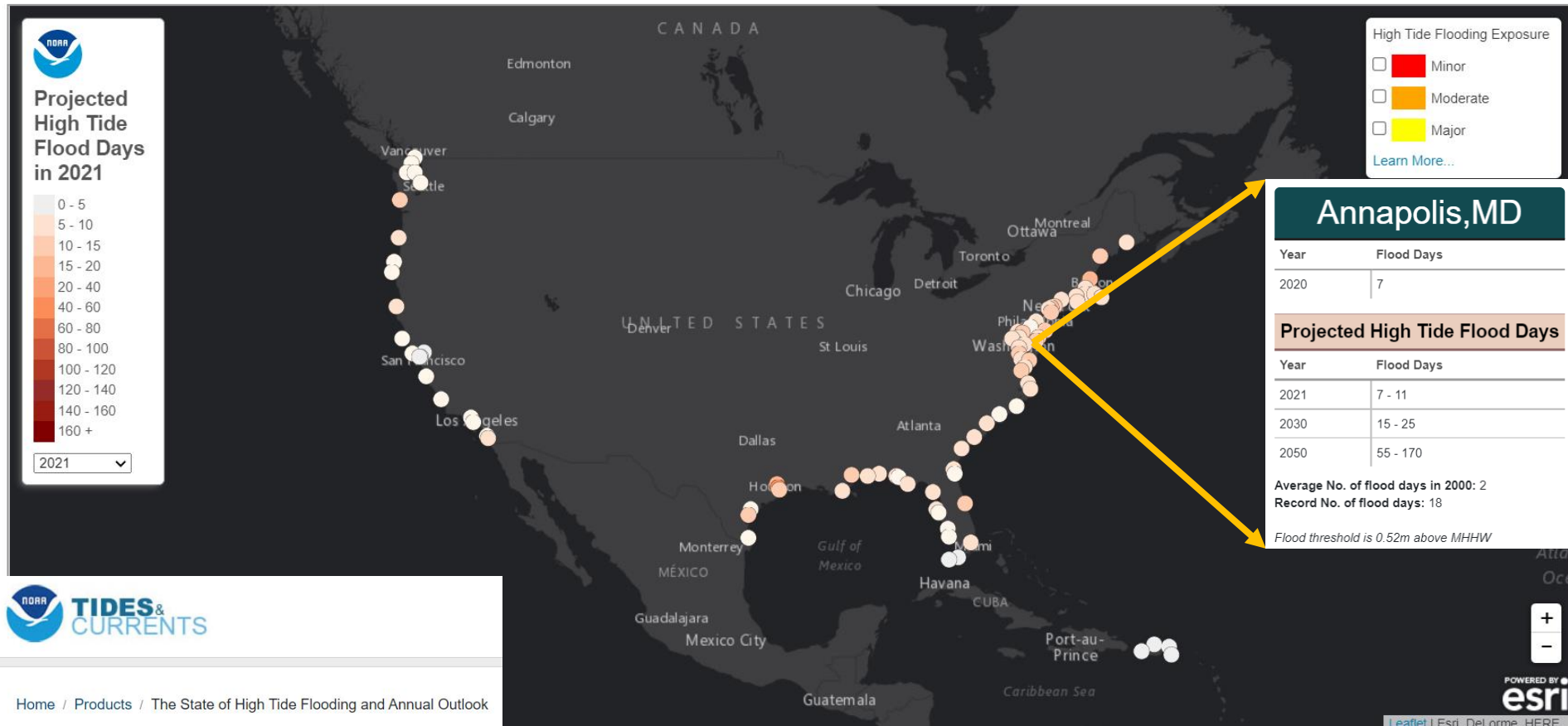


La Nina Higher

El Nino Higher

# Coastal Flooding and NOAA Annual Outlooks

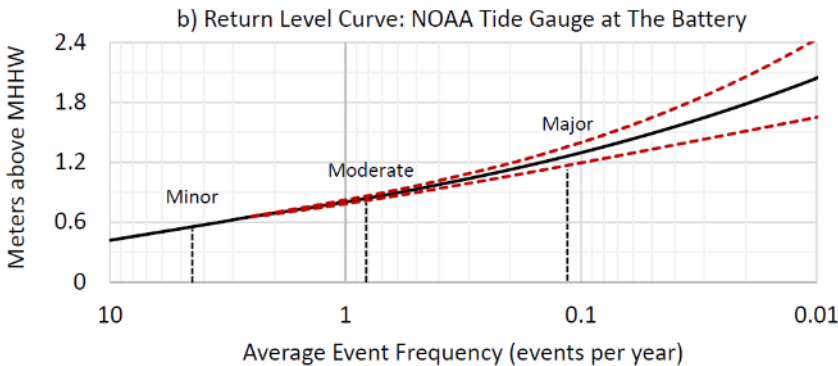
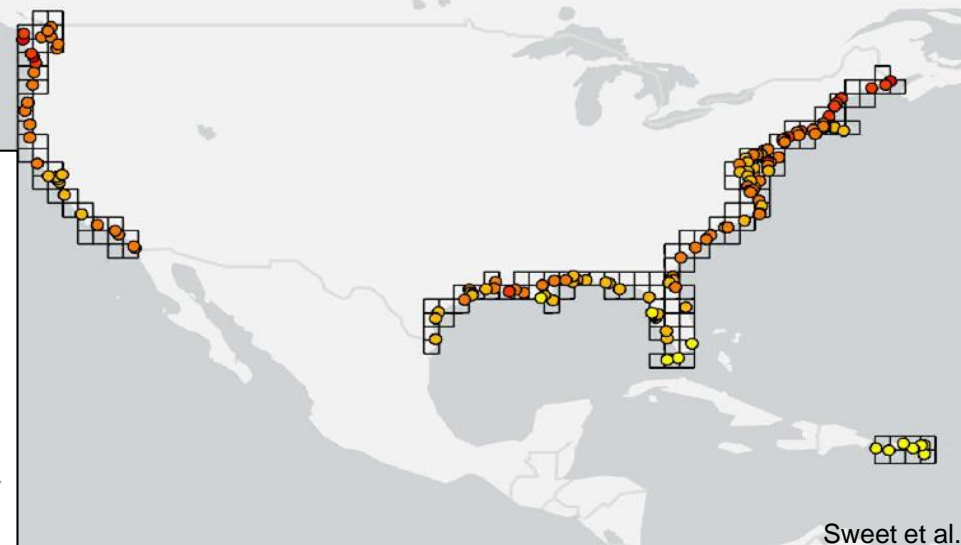
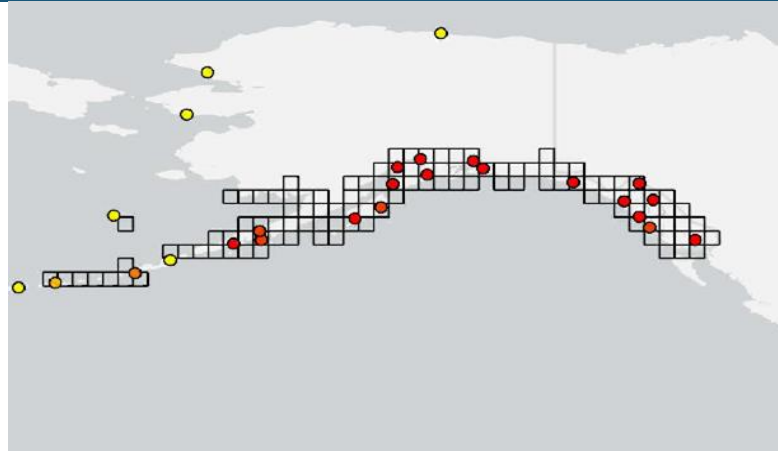
See below for the high tide flooding trends and outlooks for each tide station monitored by NOAA.





# A method to assess and map high tide flood risk (for almost all U.S. coastlines)

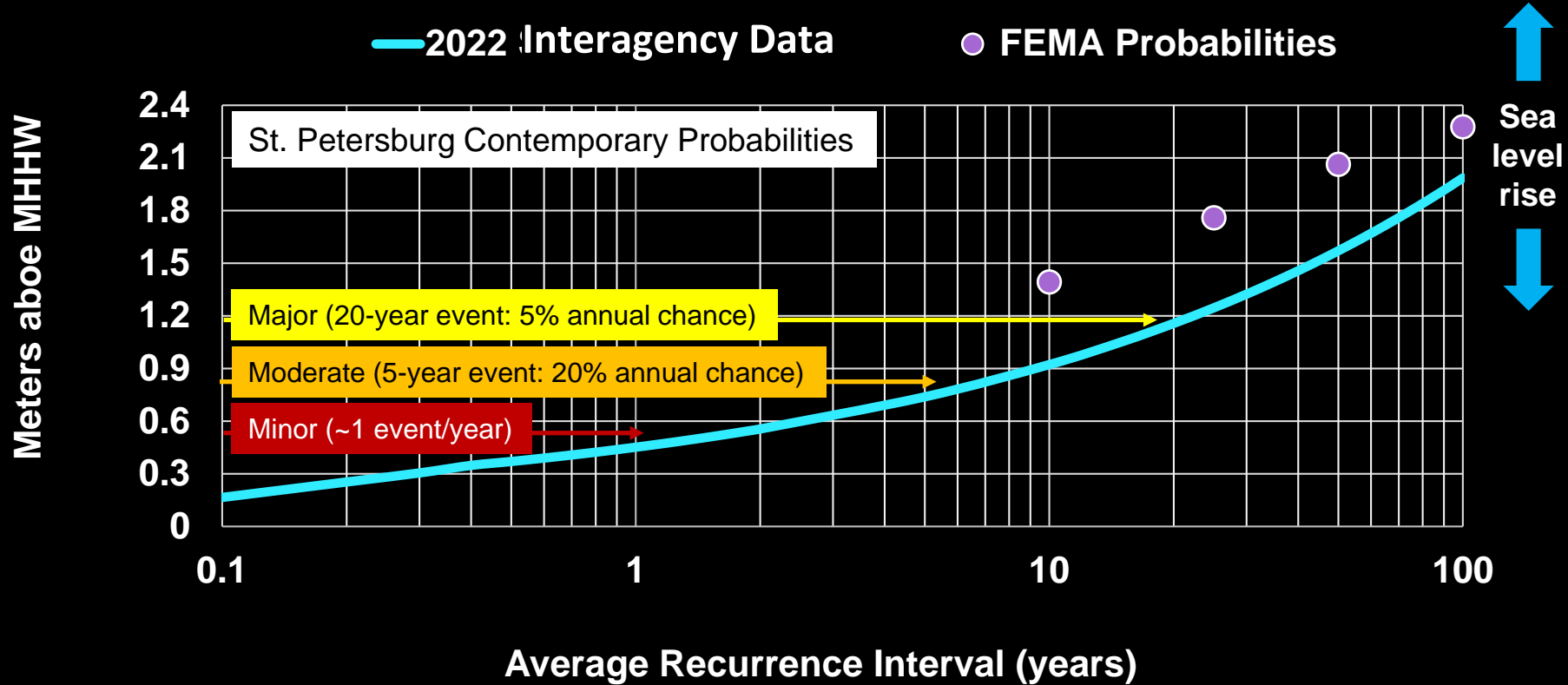
By regionalizing tide gauge data (points shown), gridded probabilities are formed that can be localized for any community.





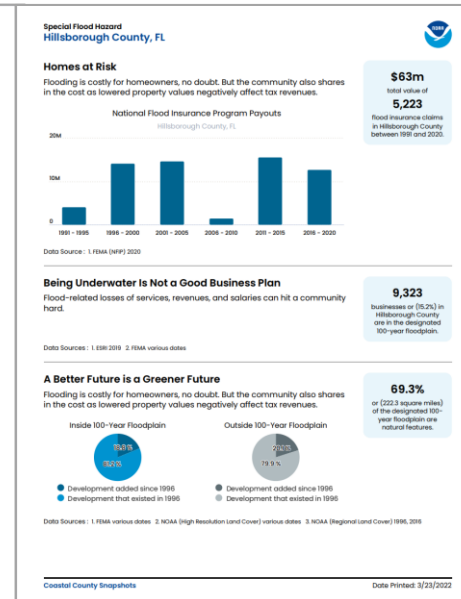
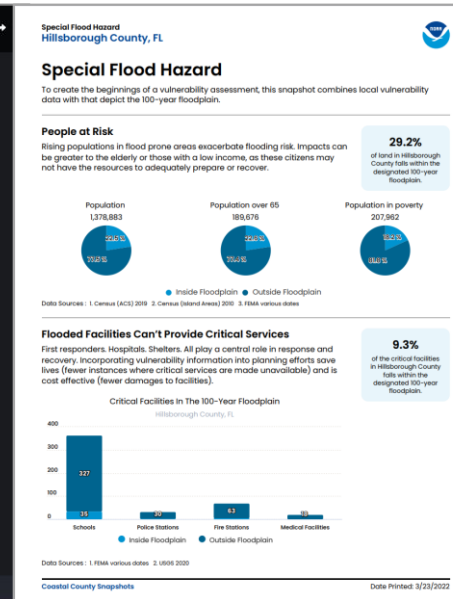
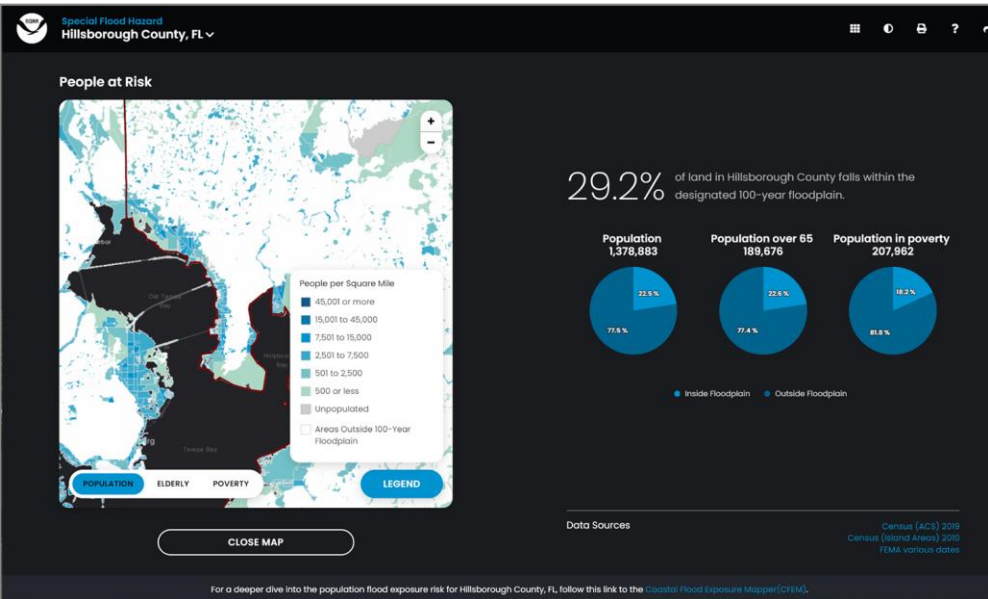
# Contemporary Coastal Flood Probabilities

as measured by tide gauges or similar (no waves)



# Coastal County Snapshots – Special Flood Hazard

- New interactive interface contains maps and interactive charts and graphs
- Ability to produce printed report to distribute to others
- Examines exposure against FEMA Special Flood Hazard Areas



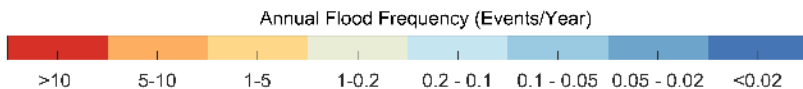
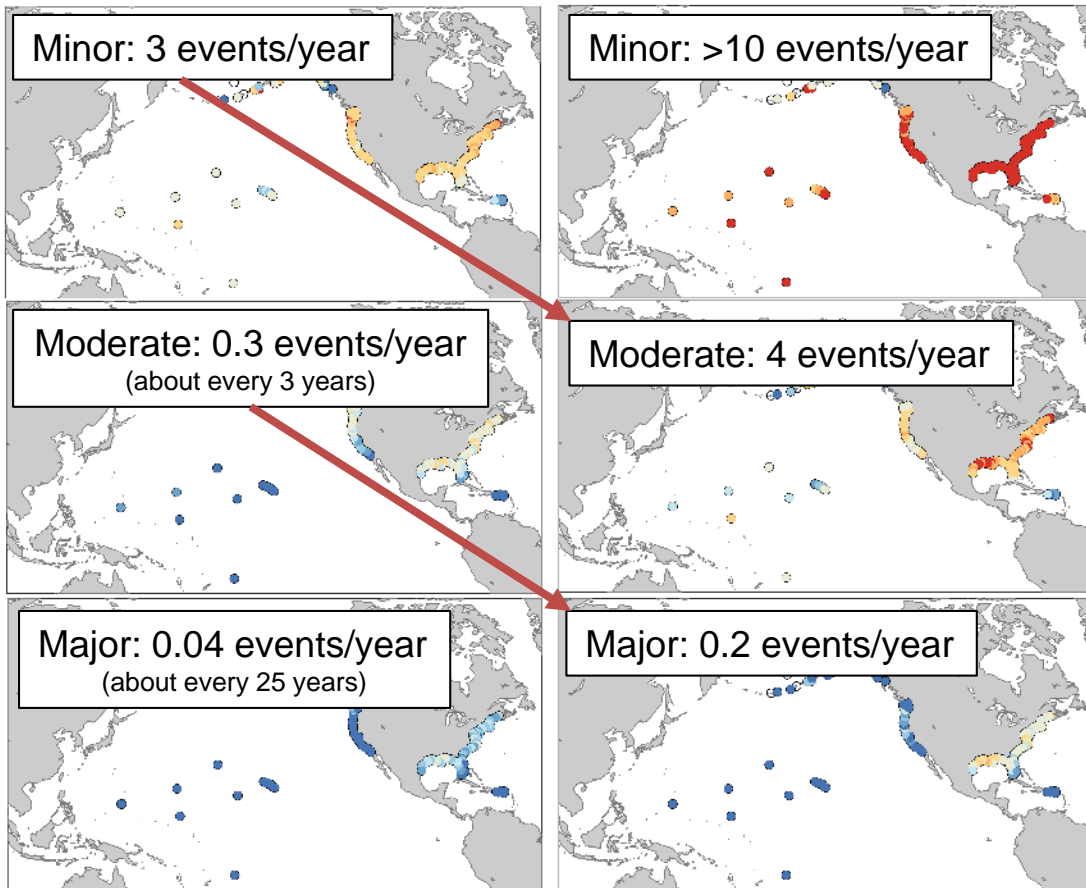
For a deeper dive into the population flood exposure risk for Hillsborough County, FL follow this link to the [Coastal Flood Exposure Mapper \(CFEM\)](#).

What does 2050 hold with 30 more years of SLR?

A **coastal flood regime shift** with significant consequences to coastal infrastructure, communities, and ecosystems without additional risk reduction measures.

## High Tide Flooding in 2020

## High Tide Flooding by 2050



In 2050, a flood regime shift:

- moderate flooding to occur more frequently than minor flooding occurs today.
- major flooding to occur slightly less than moderate flooding occurs today.



“Moderate Level High Tide Flooding”  
in Norfolk, VA  
(Oct 2019: WAVY TV)

Now (2020): 1 event/year  
Then (2050): 7-8 events/year



Let's pause...



Let's pause for questions  
from the audience.



A satellite map of a coastal region, likely a delta or estuary, with a blue overlay indicating sea level rise. The text is overlaid on the map.

# Thank You!

William Sweet ([william.sweet@noaa.gov](mailto:william.sweet@noaa.gov))

<https://oceanservice.noaa.gov/hazards/sealevelrise/sealevelrise-tech-report.html>

Ben Hamlington ([Benjamin.D.Hamlington@jpl.nasa.gov](mailto:Benjamin.D.Hamlington@jpl.nasa.gov))

<https://sealevel.nasa.gov/task-force-scenario-tool>

# Thanks to Today's Presenter...



**William Sweet**  
National Oceanic and  
Atmospheric Administration



# Thank You for Participating!



<https://www.nsta.org>

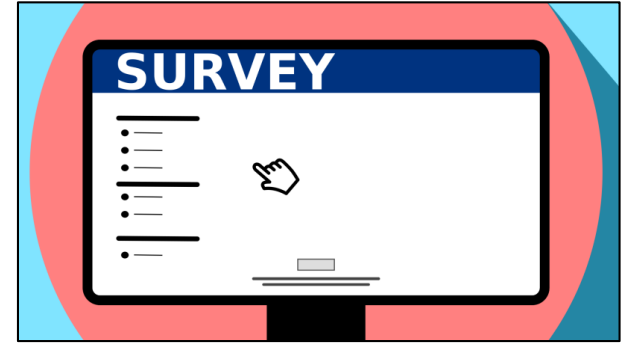
# Post-program Survey – *coming up!*



## **We value your feedback!**

The post-program survey link will be shared after the recording is stopped at the end of the program.

Your completed survey confirms your attendance which allows us to award you a certificate of participation and attendance.



# Collection of Resources



**This collection includes the slides (as PDF),  
handouts and other resources.**



**Link to the collection:**

**[https://my.nsta.org/collection/lqZGL9QxyQM\\_E](https://my.nsta.org/collection/lqZGL9QxyQM_E)**

# NSTA Web Seminars (*register now!*)



**Book Beat Live!** Every Science Lesson is in Part a Language/Reading Lesson: Using Texts to Support Student Sense Making

**April 13, 7:00 PM ET**

**NSTA/ASTE Web Seminar:** Building Tomorrow's Science Teachers: New Directions for Science Leaders, Researchers, and Educators

**April 14, 8:00 PM ET**

**Web Seminar:** Integrate NSTA in Your Course When Teaching Preservice Teachers

**April 28, 7:00 PM ET**

**Web Seminar:** Let's Talk About How to get Published in Science Scope!

**May 3, 7:00 PM ET**

**Science Update:** Primates in a Changing World

**May 5, 7:00 PM ET**

**Web Seminar:** The Power of High Quality Instructional Materials in Middle School, *sponsored by Amplify Science*

**May 12, 7:00 PM ET**

**Science Update:** Underwater Sound in Our National Marine Sanctuaries

**June 2, 7:00 PM ET**



<https://www.nsta.org/webseminars>



## **National Science Teaching Association**

Tricia Shelton, Chief Learning Officer

Flavio Méndez, Assistant Executive Director

Kate Soriano, Standards Implementation Specialist

Wendy Binder, Program Director

Michelle Phillips, eLearning Engagement Specialist

Patrice Scinta, Curriculum Writing Specialist

Holly Hereau, Instructional Materials and PL Specialist

Idari Mhadji, Project Manager

Eddie Hausknecht, Senior Manager Web Development

Don Boonstra, Technical Coordinator

***This concludes today's program.***